AD NUMBER
AD006796
CLASSIFICATION CHANGES
TO: unclassified
FROM: confidential
LIMITATION CHANGES
TO: Approved for public release, distribution unlimited
FROM: Controlling DOD Orginization: Air Technical Intelligence Center, Wright-Patterson AFB, OH.
AUTHORITY
HAF/IMIO [MDR] ltr dtd 23 Jun 2010; HAF/IMIO [MDR] ltr dtd 23 Jun 2010

AD NUMBER
AD006796
CLASSIFICATION CHANGES
TO confidential
FROM secret
AUTHORITY
31 Mar 1965 per Group-3, DoDD 5200.10

AD- 006796

SECURITY REMARKING REQUIREMENTS

DOD 5200.1-R, DEC 78

REVIEW ON 28 MAR 73

AD-

6796

TECHNICAL REPORT

NO. TR-AC-17

(RESTRICTED)

WING - STRESS ANALYSIS
MIG-15 - SERIAL NO. 120147

PROJECT NO. 10115

2 MARCH 1953

AIR TECHNICAL INTELLIGENCE CENTER
WRIGHT-PATTERSON AIR FORCE BASE
DAYTON, OHIO

SECRET
AUTH: CG, ATIC
INITIALS: F. G. Hoffman
DATE: 2 March 1953

AD 006796

TECHNICAL REPORT NO. TR-AC-17

(RESTRICTED)

WING - STRESS ANALYSIS
MIG-15 - SERIAL NO. 120147

PROJECT NO. 10115

2 MARCH 1953

Published By

AIR TECHNICAL INTELLIGENCE CENTER
WRIGHT-PATTERSON AIR FORCE BASE
OHIO

SECURITY INFORMATION

T53-2510

AF-WP-O-24 MAR 53

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

SUMMARY

Purpose

The purpose of this stress analysis is to determine the maximum probable load factor for which the wing of the MIG-15 Airplane was designed.

Factual Data

This report was prepared by Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y., under Contract No. AF 33(038)-16993. Because of manpower limitations, the work was not refined to the extent to which it was originally planned. This applies particularly to final selection of the proper amount of effective skin in the section properties.

The work is divided into three sections: the determination of section properties, calculation of unit bending moments, and the computing of permissible design load factors, as indicated by the strength of separate elements. The procedure as outlined in Reference 3 is followed essentially, and is described in detail below.

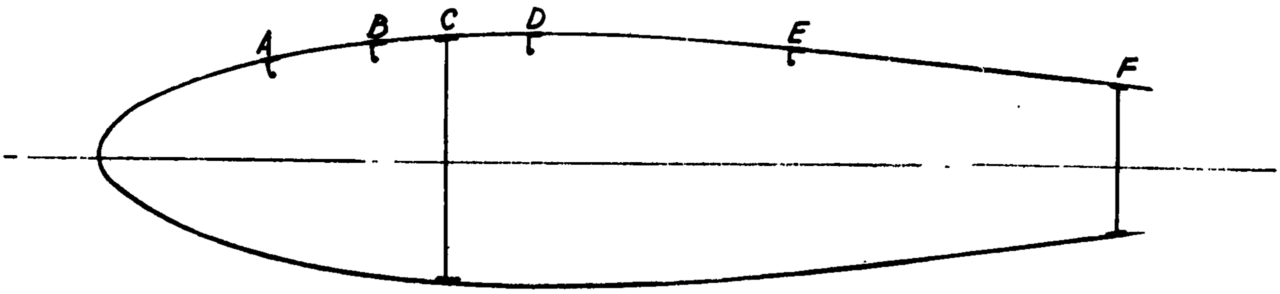
Discussion

In order to determine the bending strength of a panel, sections at three locations are analyzed. The section at the fuselage center line is a build up I-beam, whereas those at stations 117.5 and 179.4, approximately normal to front and rear spars, consist of conventional built-up beams, angles and skin. Section properties are determined for normal flight, using allowable column buckling stresses and effective skin, according to the method indicated in reference 1. From these allowable and section moduli, allowable bending moments are calculated. The amount of moment relief afforded by the ring bulkhead to Station 0 is assumed to be negligible.

For a 1-g condition at a gross weight of 10,200 pounds airload normal moments are then found, assuming a constant airload distribution over the panel. Drag load moments and the effects of angle of attack are ignored. Similarly dead-weight wing moments are computed. At the time this work was done, dead weight distribution data were unavailable, therefore, a distribution for another airplane was adapted. Finally, at contact points of the sections being investigated, "allowable" bending moments already determined are divided by net moments representing a 1-g loading, thus giving a permissible load factor.

The next step would be to increase the amount of effective skin when the crippling stress has not been attained, and to decrease the effective area of components like the rear spar at Sta. 179.4, which are much less effective than the first determination of section properties indicate. This step was not accomplished.

In the determination of allowable stresses, the material of the skin and stringers was assumed to have the same properties as 24ST aluminum alloy, an approximation substantiated by reference 4. The ultimate load factors, as computed from allowable stresses of critical items at the selected wing stations (Ref. P. 40) are recorded and the locations identified below.



ULTIMATE LOAD FACTORS

Item	Sta. 117.5	Sta. 179.4	Sta. 0
A	12.9	-	-
B	12.6	17.3	-
C	13.0	15.2	-
D	-	14.6	-
E	14.4	13.7	-
F	24.6	9.15*	-
Main Beam	-	-	10.75

*Effective area for this item should be reduced.

Conclusions

It appears that the ultimate load factor for the wing would be approximately 12, except for the fact that the factor for the carry-through steel beam is only 10.75.

However, it may be pointed out that this discrepancy does not exist if limit load factors were the criterion of strength. Using the data from reference 4, for the steel beam,

$$N \text{ (Limit)} = \frac{160000}{180000} \times 10.75 = 9.6$$

and for the panel

$$N \text{ (Limit)} = \frac{49000}{63000} \times 12 = 9.4$$

SECTION I

WING SECTION PROPERTIES

SYMBOLS

A	-	Area of cross section, square inches
b	-	Width of sections; subscript "bending"
C	-	Fixity sufficient for columns
d	-	Distances as noted
E	-	Modulus of Elasticity in tension
F_c	-	Allowable compressive stress of column
F_{cr}	-	Allowable critical buckling stress
F_{cs}	-	Crippling stress for complete section
H.T.	-	Heat Treat
I_{xx}	-	Moment of Inertia about xx Axis
I_{xp}	-	Moment of Inertia about x centroidal principal axis
I_{xy}	-	Product moment of inertia about centroidal axes
I_{yy}	-	Moment of Inertia about yy axis
I_{yp}	-	Moment of Inertia about y centroidal principal axis
L	-	Length of column
M_A	-	Bending Moment due to Air Load
M_t	-	Total Bending Moment (1G condition)
M_w	-	Bending Moment due to dead weight
N	-	Load Factor
q	-	Dynamic Pressure (psi)
t	-	Thickness
w	-	Sheet Effective Width
W	-	Weight
x'	-	Chord Reference axis
x	-	Chord Centroidal axis
x_p	-	Perpendicular distance from x principal axis to given fiber
y'	-	Wing vertical reference axis
y	-	Wing vertical centroidal axis
y_p	-	Perpendicular distance from y principal axis to given fiber
y	-	Distance from neutral axis to given fiber
ϕ	-	Angle between centroidal x and y axes and centroidal principal x and y axes
ρ	-	Radius of Gyration
Σ	-	Summation

MAIN BEAM CROSS SECTION - FUSELAGE CENTERLINE

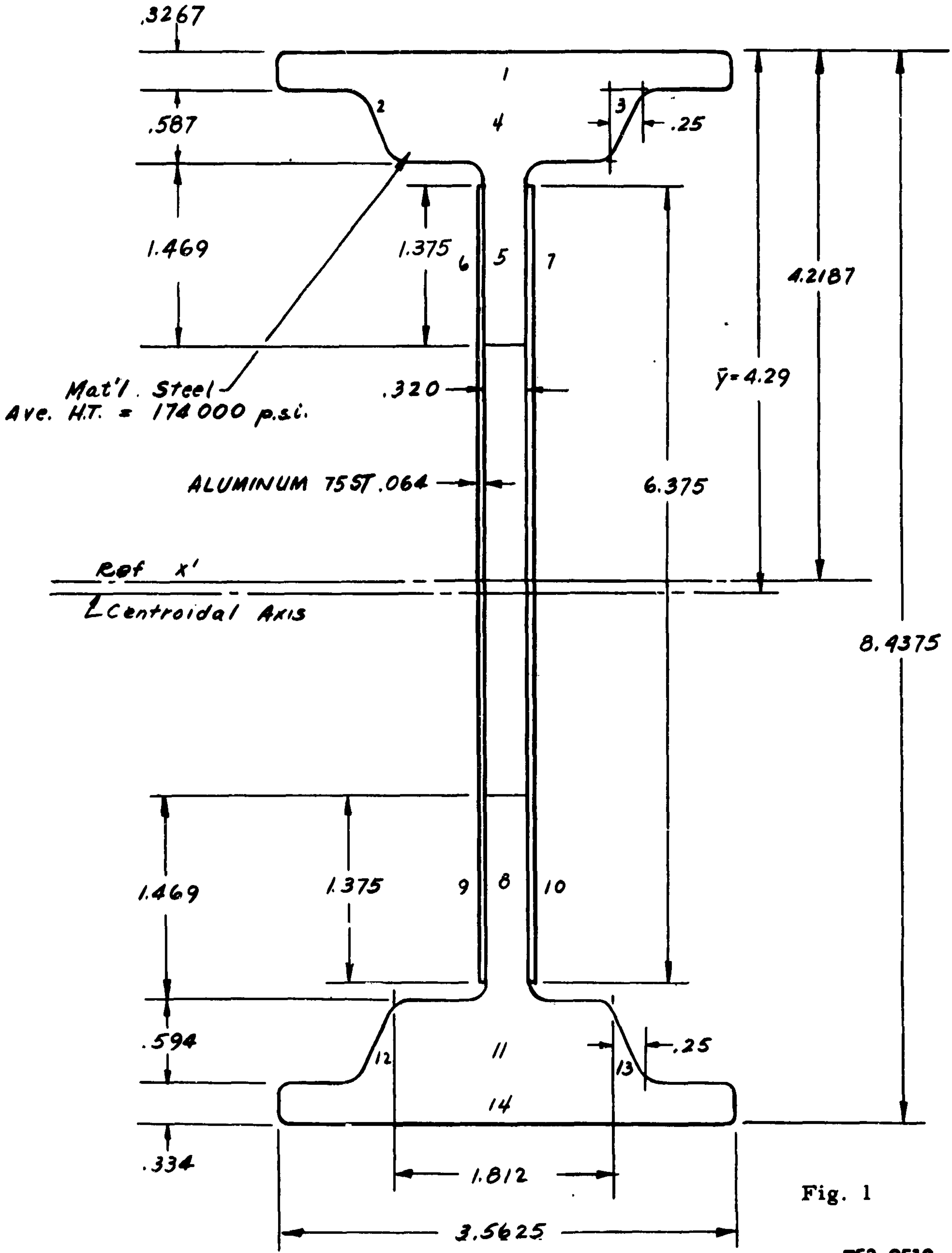


Fig. 1

T53-2510

Section Properties - Fuselage Centerline

Main Beam (Ref. P. 5)

(1) Item	(2) A	(3) y'	(4) Ay' (2)x(3)	(5) Ay'2 (3)x(4)	(6) I_{ox}
1 3.52 x .327	1.164	4.05	4.72	19.10	.010
2 .25 x .587/2	.073	3.86	.28	1.09	-
3 .25 x .587/2	.073	3.86	.28	1.09	-
4 .587 x 1.812	1.062	3.31	3.50	11.53	.030
5 .320 x 1.47	.470	2.57	1.21	3.10	.085
*6 1.375 x .064/2.8	.031	2.52	.07	.20	-
7 1.375 x .064/2.8	.031	2.52	.07	.20	-
8 1.47 x .32	.470	-2.56	-1.20	3.06	.085
*9 1.375 x .064/2.8	.031	-2.51	- .07	.20	-
*10 1.375 x .064/2.8	.031	-2.51	- .07	.20	-
11 1.812 x .594	1.075	-3.59	-3.86	13.80	.032
12 .594 x .25/2	.074	-3.69	- .27	1.01	-
*13 1.375 x .064/2.8	.031	-3.69	- .11	.42	-
14 3.56 x .334	1.190	-4.05	-4.82	19.50	.013
Σ	5.806		- .279	74.50	.255

*Adjusted for steel by modulus ratio.

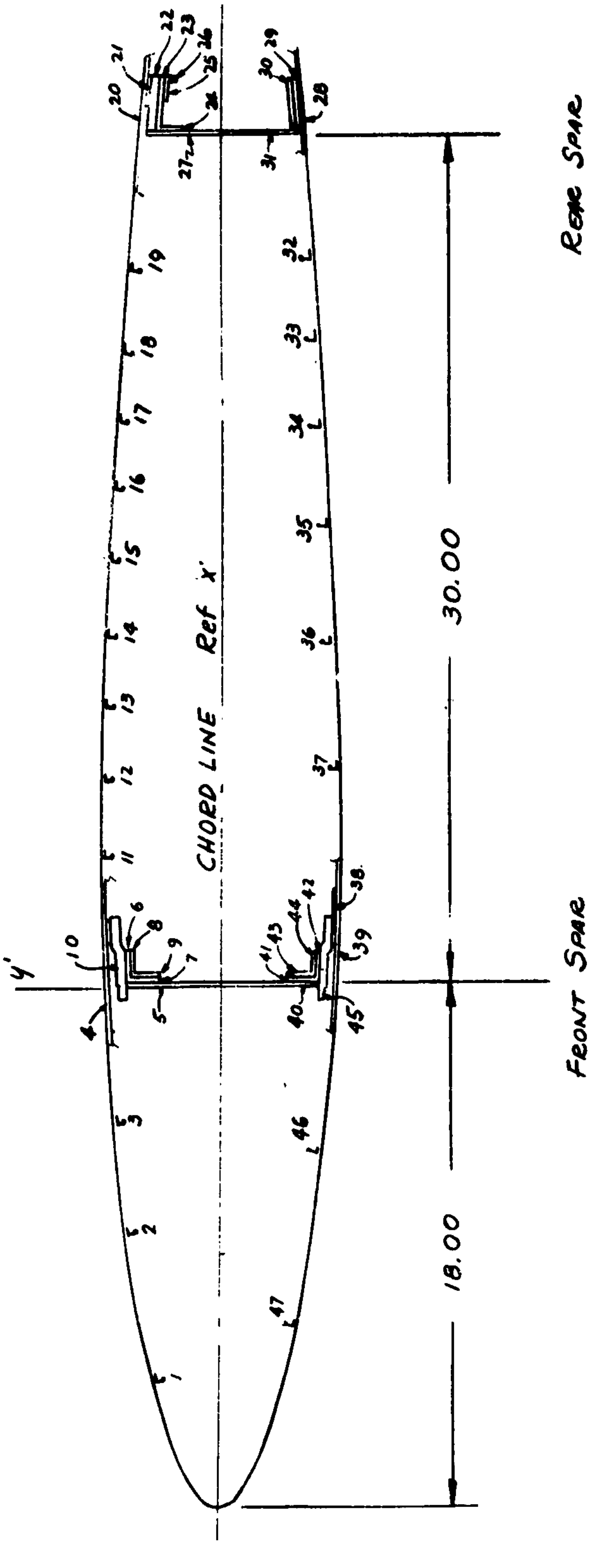
$$\bar{y} = \frac{\Sigma Ay'}{\Sigma A} = \frac{-.279}{5.806} = -.048 \text{ in.}$$

$$I_{xx} = \Sigma Ay'^2 + \Sigma I_{ox} - \Sigma A\bar{y}^2$$

$$= 74.5 + .255 - 5.806 \times (-.048)^2$$

$$= 74.755 - .013$$

$$= 74.74 \text{ in.}^4$$



SECTION - WING STA 117.5 (Ref. 2)

Fig. 2

T53-2510

SECTION PROPERTIES - WING STATION 117.5

(Ref. P. 7)

1 Item	2 A	3 y'	4 Ay'	5 Ay'^2	6 x'	7 Ax'	8 Ax'^2	9 Ax'y'
1	.298	3.156	.94	2.95	-11.01	-3.28	36.1	-10.3
2	.298	3.484	1.04	3.60	- 5.84	-1.74	10.1	- 6.0
3	.298	4.281	1.28	5.48	- 2.25	- .67	1.5	- 2.8
4	.130	4.578	.59	2.74	1.78	.23	.4	1.0
5	.115	3.312	.38	1.26	-	-	-	-
6	.156	3.812	.59	2.26	.70	.10	.0	.4
7	.195	3.312	.64	2.14	.12	.02	.0	.0
8	.058	3.234	.18	.60	.23	.01	.0	.0
9	.067	3.703	.24	.91	.73	.05	.0	.1
10	.981	4.190	4.11	17.25	1.18	1.17	1.3	4.9
11	.425	4.547	1.93	8.80	3.60	1.53	5.5	6.9
12	.425	4.625	1.96	9.10	7.12	3.02	21.6	13.9
13	.425	4.656	1.98	9.20	10.17	4.33	44.1	20.2
14	.425	4.656	1.98	9.20	13.04	5.55	72.3	25.8
15	.425	4.578	1.94	8.72	15.96	6.80	109.0	31.2
16	.425	4.453	1.89	8.43	18.89	8.04	152.0	35.8
17	.425	4.281	1.82	7.83	21.76	9.22	200.0	39.5
18	.425	4.015	1.70	6.84	24.70	10.50	259.0	42.1
19	.425	3.718	1.58	5.86	27.28	11.60	316.0	43.2
20	.138	3.390	.46	1.59	31.25	4.31	134.0	14.6
21	.039	3.219	.12	.40	31.90	1.24	39.8	4.0
22	.570	3.156	1.79	5.66	31.25	17.80	554.0	56.0
23	.214	2.969	.63	1.88	31.25	6.68	208.0	19.8
24	1.000	2.500	2.50	6.25	30.07	30.07	906.0	75.2
25	.139	2.797	.39	1.08	31.78	4.42	140.4	12.4
26	.065	2.469	.16	.39	32.18	2.09	67.4	5.1
27	.113	2.703	.30	.82	30.03	3.38	101.8	9.2
28	.228	-3.094	- .70	2.18	30.78	7.03	216.2	-21.7
29	.375	-2.922	-1.09	3.18	30.78	11.55	356.0	-33.8
30	.111	-2.750	- .30	.84	30.78	3.42	105.4	- 9.4
31	.156	-1.547	- .24	.37	30.03	4.73	140.4	- 7.2
32	.390	-3.281	-1.28	4.20	26.81	10.45	280.0	-34.3
33	.393	-3.484	-1.37	4.78	23.18	9.12	212.0	-31.8
34	.396	-3.578	-1.42	5.07	19.62	7.76	152.5	-27.8
35	.419	-3.703	-1.55	5.70	15.53	6.50	101.0	-24.0
36	.401	-3.734	-1.49	5.57	11.57	4.65	53.7	-17.2
37	.417	-3.703	-1.54	5.70	7.90	3.30	26.2	-12.1
38	.168	-3.641	- .61	2.22	2.57	.43	1.1	- 1.5
39	.670	-3.672	-2.46	9.00	1.68	1.13	1.1	- 4.1
40	.184	-1.969	- .36	.71	-	-	-	-
41	.188	-2.133	- .40	.85	.12	.02	.0	- .0
42	.203	-2.633	- .53	1.40	.62	.12	.0	- .3
43	.062	-2.031	- .12	.25	.23	.01	.0	- .0
44	.058	-2.500	- .14	.36	.73	.04	.0	- .1
45	1.210	-3.106	-3.76	11.60	.89	1.08	.9	- 3.3
46	.554	-3.156	-1.75	5.60	- 6.12	-3.39	20.7	+10.7
47	.554	-2.469	-1.36	3.38	-11.93	-6.61	78.6	+16.3
Σ	15.836		+10.67	+204.26		+188.46	5126.7	+244.1

T53-2510

$\bar{y} = \frac{\Sigma Ay'}{\Sigma A} = \frac{10.67}{15.836} = \underline{.673"}$ (Ref. I - P. A3.11) (Ref. P. 8)

$I_{xx} = \Sigma Ay'^2 - \Sigma A (\bar{y})^2$ (Ref. I - P. A3.11) (Ref. P. 8)
$= 204.26 - 15.836 (.673)^2$
$= 204.36 - 7.2$
$= \underline{197.16}$ in.^{4}

$\bar{x} = \frac{\Sigma Ax'}{\Sigma A} = \frac{188.46}{15.836} = 11.9"$ (Ref. I - P. A3.11) (Ref. P. 8)

$I_{yy} = \Sigma Ax'^2 - \Sigma A (\bar{x})^2$ (Ref. I - P. A3.11) (Ref. P. 8)
$= 5126.7 - 15.836 (11.9)^2$
$= 5126.7 - 2250$
$= 2876.7$ in.^{4}

$I_{xy} = \Sigma Ax'y' - \Sigma A\bar{y}\bar{x}$ (Ref. I - P. A3.11) (Ref. P. 8)
$= 244.13 - (15.836 \times .673 \times 11.9)$
$= 244.13 - 127$
$= \underline{117.13}$ in.^{4}

$\text{Tan } 2\phi = \frac{2 I_{xy}}{I_y - I_x}$ (Ref. I - P. A3.11)

$\text{Tan } 2\phi = \frac{2 \times 117.13}{2876.7 - 197.16}$

$\text{Tan } 2\phi = \frac{234.3}{2679.5} = .0877$

$2\phi = 5^\circ$

$\phi = 2.5^\circ$

$I_{xp} = I_x \text{ Cos}^2\phi + I_y \sin^2\phi - 2 I_{xy} \sin\phi \times \text{Cos}\phi$ (Ref. I - P. A3.11)

$I_{xp} = 197.16 \times (.999)^2 + 2876.7 \times (.0436)^2 - [234.3 \times .0436 \times .999]$

$I_{xp} = 197.16 + 5.45 - 10.2$

$I_{xp} = 192.41$ in.^{4}

$I_{yp} = I_x \sin^2\phi + I_y \text{ Cos}^2\phi + 2 I_{xy} \sin\phi \times \text{Cos}\phi$ (Ref. I - P. A3.12)

$I_{yp} = 197.16 \times (.0436)^2 + 2876.7 \times (.999)^2 + [234.3 \times .0436 \times .999]$

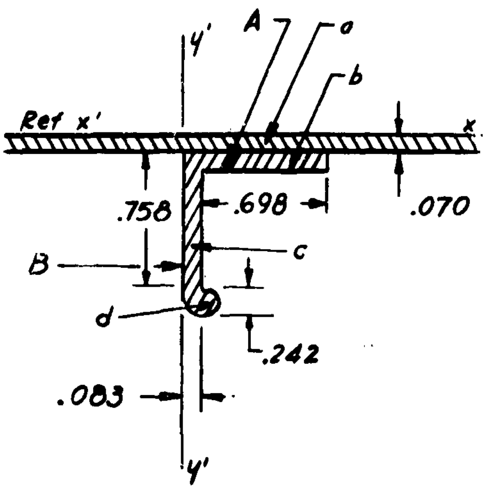
$I_{yp} = .374 + 2876.7 + 10.2$

$I_{yp} = 2887.3$ in.^{4}

T53-2510

Section Properties - Wing Station 117.5

Bulb Angle Section - Items 1, 2, 3. (Ref. P. 7)



Buckling Stress

Element A

$$\frac{b_1}{t_1} = \frac{.698}{.083} = 8.4 \qquad F_{cr_1} = 38{,}000 \text{ psi}$$

Element B (Ref. I - Fig. B5.13)

$$\frac{b_2}{t_2} = \frac{.917}{.083} = 11 \qquad F_{cr_2} = 48{,}750 \text{ psi}$$ (Ref. I - Fig. B5.13)

$$F_{cs} = \frac{(F_{cr_1}\, b_1 + F_{cr_2}\, b_2)}{b_1 + b_2}$$ (Ref. I - P. B5.7(6))

$$F_{cs} = \frac{(38{,}000 \times .698) + (48750 \times .917)}{.1615}$$

$$F_{cs} = \frac{71{,}100}{1.615} = 44{,}000 \text{ psi for Bulb Angle}$$

Effective Skin

$$w = 1.7\, t \sqrt{\frac{E}{F_{cs}}}$$ (Ref. I - P. B4.2(6))

$$= 1.7\,(.070) \sqrt{\frac{10.3 \times 10^6}{4.4 \times 10^4}} = 1.82 \text{ in.}$$

T53-2510

Section Properties - Wing Station 117.5

Section Properties (Ref. P. 10)

Item	A	y'	Ay'	Ay'²	x'	Ax'
a 1.8 (.070)	.127	.035	.004	.0001	.432	.055
b .698 (.083)	.058	.107	.006	.0007	.432	.025
c .758 (.083)	.063	.445	.028	.0125	.041	.003
d 3.14 (.141)	.046	.945	.044	.041	.121	.005
Σ	.294	ȳ=.28	.082	.054	x̄=.30	.088

$$\bar{y} = \frac{\Sigma A y'}{\Sigma A} = \frac{.082}{.294} = .28'' \quad \text{(Ref. I - P. A3.11)}$$

$$\bar{x} = \frac{\Sigma A x'}{\Sigma A} = \frac{.088}{.294} = .30''$$

$$I_{xx} = \Sigma A y'^2 - \Sigma A \bar{y}^2 \quad \text{(Ref. I - P. A3.11)}$$

$$I_{xx} = .054 - .294\ (.28)^2$$

$$= .031 \text{ in.}^4$$

$$\rho = \sqrt{\frac{I_{xx}}{A}} = \frac{.031}{.294} = .326 \text{ in.} \quad \text{(Ref. I - P. A3.5)}$$

Column Allowable Buckling Stress

Using the Johnson Column Formula

$$F_c = F_{cs} - \frac{(F_{cs})^2 \times \left(\frac{L}{\rho}\right)^2}{4\, C \pi^2 E} \quad \text{(Ref. I - P. B6.4(3))}$$

$$F_c = 44{,}000 - \frac{(44000)^2 \left(\frac{10.75}{.326}\right)^2}{4\ (2)(3.14)^2(10.3 \times 10^6)}$$

$$= 44{,}000 - 2620 = 41{,}380 \text{ psi}$$

Revised Effective Skin

$$w = 1.7\, t \sqrt{\frac{E}{F_c}} \quad \text{(Ref. I - P. B6.4)}$$

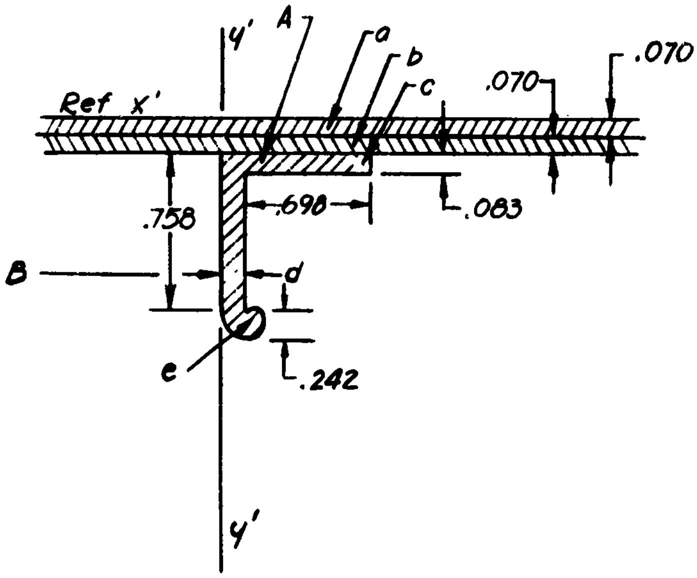
$$= 1.7\ (.07)\sqrt{\frac{10.3 \times 10^6}{4.138 \times 10^4}} = 1.88 \text{ in.}$$

Total area $A = .167 + (1.88 \times .07) = .298 \text{ in.}^2$

T53-2510

Section Properties - Wing Station 117.5

Bulb Angle Section - Items 11, 12, 13, 14, 15, 16, 17, 18, 19. (Ref. P. 7)



Buckling Stress

Element A

$$\frac{b_1}{t_1} = \frac{.698}{.083 + .035} = 5.9$$

F_{cr_1} = 43,000 psi

Element B (Ref. I - Fig. B5.13)

$$\frac{b_2}{t_2} = \frac{.917}{.083} = 11$$

F_{cr_2} = 48,750 psi (Ref. I - Fig. B5.13)

$$F_{cs} = \frac{(43{,}000 \times .698 \times .118) + (48{,}750 \times .083 \times .917)}{(.698 \times .118) + (.917 \times .083)}$$

(Ref. I - P. B5.7(5))

$$F_{cs} = \frac{3540 + 3710}{.0824 + .076} = \frac{7250}{.1584} = 45{,}900 \text{ psi}$$

Effective Skin

$$W = 1.7 \times .070 \sqrt{\frac{10.3 \times 10^6}{4.59 \times 10^4}}$$

(Ref. I - P. B4.2(6))

W = 1.78 in.

Section Properties - Wing Station 117.5

Section Properties (Ref. P. 12)

Item	A	y'	Ay'	Ay'²	x'	Ax'
a 1.78 x .070	.125	.035	.0044	.00015	.432	.0540
b 1.78 x .070	.125	.105	.0131	.00138	.432	.0540
c .698 x .083	.058	.177	.0010	.00182	.432	.0250
d .758 x .083	.063	.514	.0324	.01660	.041	.0026
e 3.14 x(.121)²	.046	1.015	.0467	.04740	.121	.0055
Σ	.417	$\bar{y}$=.234	.0976	.06735	$\bar{x}$=.339	.1411

$\bar{y} = \frac{.0976}{.417} = .234$ in. (Ref. I - P. A3.11)

$\bar{x} = \frac{.1411}{.417} = .339$ in.

$I_{xx} = \Sigma A y'^2 - \Sigma A (\bar{y})^2$ (Ref. I - P. A3.11)

$I_{xx} = .067 - (.417 \times (.234)^2)$

$I_{xx} = .067 - .023$

$I_{xx} = .044$ in.^{4}

$\rho = \sqrt{\frac{.044}{.417}} = .324$ in. (Ref. I - P. A3.5)

Column Allowable Buckling Stress (Ref. I - P. B6.4(3))

$F_c = 45{,}900 - \frac{(45{,}900)^2 \times \left(\frac{10.75}{.324}\right)^2}{4 \times 2 \times (3.14)^2 \times 10.3 \times 10^6}$ (Ref. P. 12)

$F_c = 45{,}900 - \frac{23.2 \times 10^{11}}{8.1 \times 10^8}$

$F_c = 45{,}900 - 2860 = 43{,}040$ psi

Revised Effective Skin

$w = 1.7 \times .070 \sqrt{\frac{10.3 \times 10^6}{4.304 \times 10^4}}$ (Ref. I - P. B6.4)

$w = 1.84$ in.

Area of Skin and Doubler

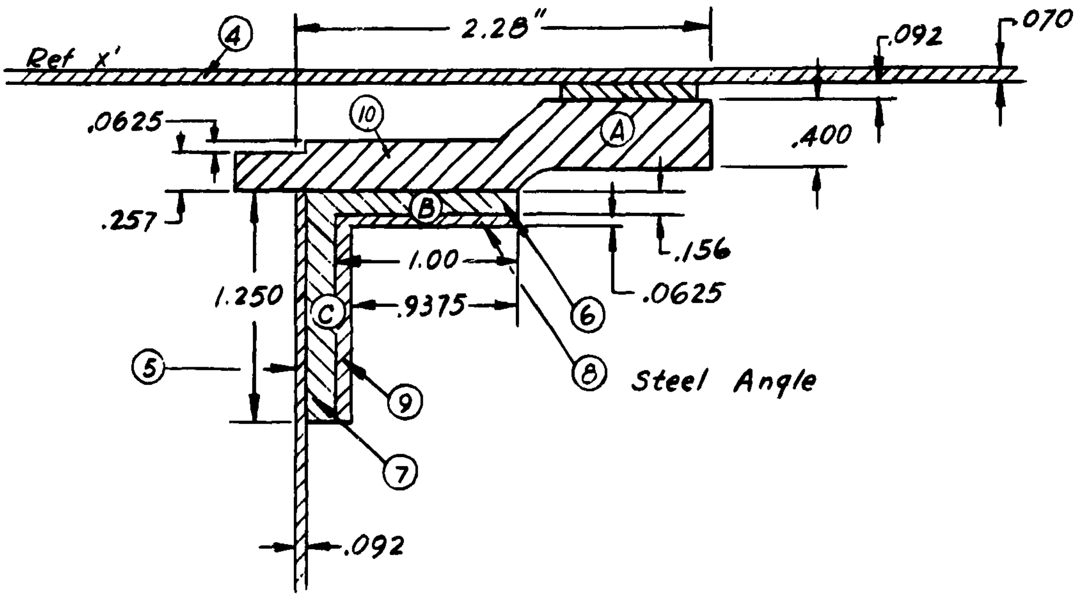
$A = 1.84 \times .140 = .258$ in.^{2}

Total Area $= .167 + .258 = .425$ in.^{2}

T53-2510

Section Properties - Wing Station 117.5

Front Spar Section - Items 4, 5, 6, 7, 8, 9, 10. (Ref. P. 7)



Buckling Stress

Element A

$$\frac{b_1}{t_1} = \frac{2.28}{.359} = 6.3$$

$F_{cr_1} =$ 42,500 (Ref. I - Fig. B5.13)

Element B

$$\frac{b_2}{t_2} = \frac{.9375}{.218} = 4.3$$

$F_{cr_2} =$ 46,500 psi (Ref. I - Fig. B5.13)

Element C

$$\frac{b_3}{t_3} = \frac{.938}{.264} = 3.55$$

$F_{cr_3} =$ 49,000 psi (Ref. I - Fig. B5.13)

Section Properties - Wing Station 117.5

$$F_{cs} = \frac{(42.500x2.28x.359)+(46.500x.937x.218)+(49.000x.938x.264)}{(2.28x.359)+(.937x.218)+(.938x.264)}$$

$$F_{cs} = \frac{56.450}{1.272} = 44{,}500 \text{ psi}$$ (Ref. P. 14)

Effective Skin

$$w = 1.7 \times .070 \sqrt{\frac{10.3 \times 10^6}{4.45 \times 10^4}}$$ (Ref. I - P. B4.2(6))

$$w = 1.81 \text{ in.}$$

Section Properties

Item		A	y'	Ay'	Ay'^2
4	1.81 x .070	.126	.035	.004	0
5	1.250 x .092	.115	1.30	.149	.194
6	1.00 x .156	.156	.800	.125	.100
7	1.250 x .156	.195	1.30	.254	.254
8	.9375 x .062	.058	.950	.055	.055
9	1.09 x .062	.067	1.42	.095	.095
10		.981	.400	.392	.392
	Σ	1.698	ȳ=.633	1.074	.968

(Ref. P. 14)

$$\bar{y} = \frac{1.074}{1.698} = .633$$

$$I_{xx} = \Sigma A y'^2 - \Sigma A \bar{y}^2$$ (Ref. I - P. A3.11)

$$I_{xx} = .968 - (1.698 \times (.633)^2)$$

$$I_{xx} = .968 - .68 = .288 \text{ in.}^4$$

$$\rho = \sqrt{\frac{.288}{1.698}} = .412 \text{ in.}$$ (Ref. I - P. A3.11)

Column Allowable Buckling Stress

$$F_c = F_{cs} - \frac{F_{cs} \times \left(\frac{L}{\rho}\right)^2}{4 c \pi^2 E}$$ (Ref. I - P. B6.4(3))

$$F_c = 44{,}500 - \frac{(44{,}500) \times \left(\frac{10.75}{.412}\right)^2}{8.1 \times 10^8}$$

$$F_c = 44{,}500 - 1670 = 42{,}830 \text{ psi}$$

T53-2510

Section Properties - Wing Station 117.5

Revised Effective Skin

$$w = 1.7\,t\sqrt{\frac{E}{F_c}} \qquad \text{(Ref. I - P. B6.4)}$$

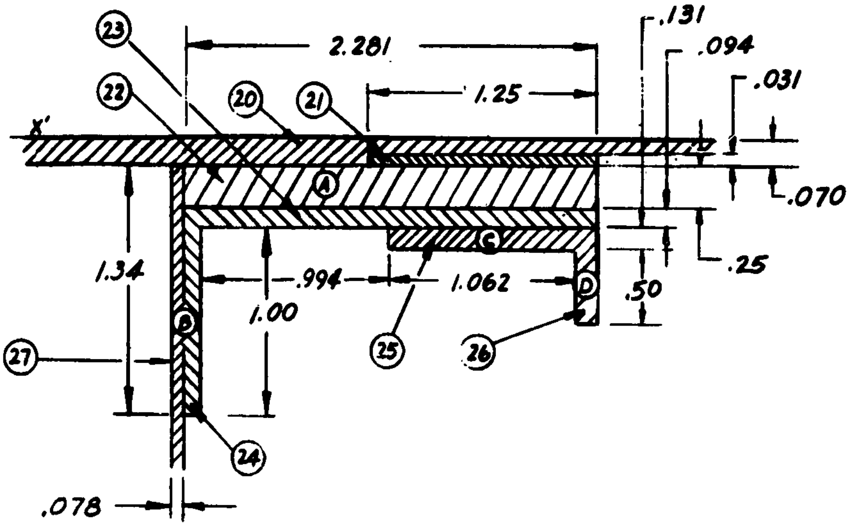
$$w = 1.7 \times .07\sqrt{\frac{10.3 \times 10^6}{4.28 \times 10^4}} \qquad \text{(Ref. P. 15)}$$

$$w = 1.85 \text{ in.}$$

Area of Skin

$$A = 1.85 \times .070 = .130 \text{ in.}^2$$

Rear Spar Section - Items 20, 21, 22, 23, 24, 25, 26, 27. (Ref. P. 7)



Buckling Stress

Element A

$$\frac{b_1}{t_1} = \frac{2.187}{.297} = 7.4$$

$$F_{cr_1} = 40{,}000 \text{ psi} \qquad \text{(Ref. I - Fig. B5.13)}$$

T53-2510

Section Properties - Wing Station 117.5

Element B

$$\frac{b_2}{t_2} = \frac{1.00}{.133} = 7.5$$

F_{cr_2} = 40,000 psi (Ref. I - Fig. B5.13)

Element C

$$\frac{b_2}{t_2} = \frac{1.062}{.131} = 8.1$$ (Ref. I - Fig. B5.13)

F_{cr_3} = 39,500 psi

Element D

$$\frac{b_4}{t_4} = \frac{.500}{.131} = 3.8$$ (Ref. I - Fig. B5.13)

F_{cr_4} = 48,500 psi

$$F_{cs} = \frac{(40,000 x 2.187 x .297)+(48,500 x .5 x .131)+(40,000 x 1. x .133)+}{2.187 x .297)+(.5 x .131)+(1.00 x .133)+}$$

$$\frac{(39,500 x 1.062 x .131)}{1.062 x .131)}$$ (Ref. I - P. B5.7 (5))

$$F_{cs} = \frac{39,990}{.987} = 40,500 \text{ psi}$$

Effective Skin

$$w = 1.7 \times .070 \sqrt{\frac{10.3 \times 10^6}{4.05 \times 10^4}}$$ (Ref. I - P. B4.2(6))

w = 1.90 in.

T53-2510

Section Properties - Wing Station 117.5

Section Properties (Ref. P. 16)

Item		A	y'	Ay'	Ay'^2
20	1.90 x .070	.133	.035	.0046	.00016
21	1.25 x .031	.039	.081	.0031	.00026
22	2.281 x .25	.570	.222	.1265	.0281
23	2.281 x .094	.214	.394	.0843	.0332
24	1.00 x .094	.094	.941	.0885	.0890
25	1.062 x .131	.139	.506	.0704	.0356
26	.631 x .131	.082	.756	.0620	.0468
27	1.34 x .078	.104	.767	.0797	.0614
	Σ	1.374	$\bar{y}$=.378	.519	.2945

$$\bar{y} = \frac{\Sigma Ay'}{\Sigma A}$$ (Ref. I - P. A3.11)

$$\bar{y} = \frac{.519}{1.374} = .378 \text{ in.}$$

$$I_{xx} = \Sigma Ay'^2 - \Sigma A\bar{y}^2$$ (Ref. I - P. A3.11)

$$I_{xx} = .2945 - 1.374 \times (.378)^2$$

$$I_{xx} = .2945 - .195 = .0995 \text{ in.}^4$$

$$\rho = \sqrt{\frac{I_{xx}}{A}}$$ (Ref. I - P. A3.5)

$$= \sqrt{\frac{.0995}{1.374}} = .269 \text{ in.}$$

Column Allowable Buckling Stress (Ref. I - P. B6.4(3))

$$F_c = 40{,}500 - \frac{(40{,}500) \times \left(\frac{10.75}{.269}\right)^2}{8.1 \times 10^8}$$ (Ref. P. 17)

$$F_c = 40{,}500 - \frac{26.2 \times 10^{11}}{8.1 \times 10^8}$$

$$F_c = 40{,}500 - 3240 = 37{,}260 \text{ psi}$$

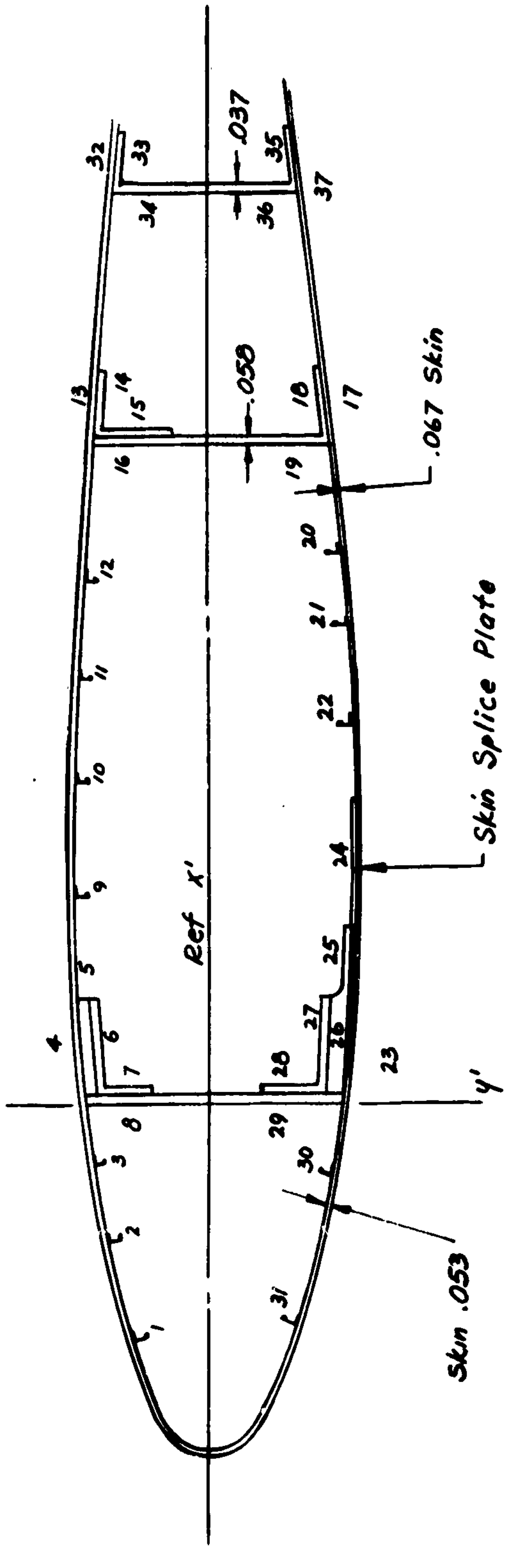
Section Properties - Wing Station 117.5

Revised Effective Skin (Ref. I - P. B6.4)

$$w = 1.7 \times .070 \sqrt{\frac{10.3 \times 10^6}{3.726 \times 10^4}}$$ (Ref. P. 18)

$$w = 1.98 \text{ in.}$$

Area of skin $A = 1.98 \times .070 = .138 \text{ in.}^2$



SECTION - WING STA 179.4 (Ref. 2)

Fig. 3

SECTION PROPERTIES - WING STATION 179.4

1 Item	2 A	3 y'	4 Ay'	5 Ay'^2	6 x'	7 Ax'	8 Ax'^2	9 Ax'y'
1	.243	2.250	.547	1.235	-11.187	-2.72	30.4	- 6.12
2	.243	3.156	.765	2.405	- 6.156	-1.49	9.2	- 4.72
3	.243	3.453	.840	2.890	- 2.984	- .72	2.1	- 2.50
4	.077	3.890	.300	1.170	.641	.04	.0	.19
5	.187	3.781	.706	2.675	.656	.12	.0	.46
6	.150	3.640	.546	1.980	.656	.09	.0	.35
7	.109	3.125	.340	1.060	.094	.01	-	.03
8	.067	3.250	.218	.710	-	-	-	-
9	.243	3.875	.940	3.640	6.844	1.66	11.3	6.42
10	.243	3.969	.965	3.840	11.812	2.77	33.8	11.00
11	.243	3.922	.953	3.740	16.719	4.06	68.0	15.90
12	.243	3.609	.876	3.160	21.596	5.25	113.0	18.90
13	.097	3.453	.335	1.160	26.000	2.52	65.8	8.70
14	.051	3.359	.171	.575	26.031	1.33	34.4	4.46
15	.058	2.937	.170	.502	25.560	1.48	37.9	4.35
16	.058	2.937	.170	.502	25.500	1.48	37.6	4.34
17	.355	-2.800	-.995	2.770	25.946	9.22	238.0	-25.80
18	.058	-2.750	-.159	.437	26.033	1.51	39.2	- 4.15
19	.116	-1.812	-.210	.380	25.500	2.96	75.5	- 5.36
20	.586	-3.000	-1.760	5.280	20.096	11.78	237.5	-35.40
21	.586	-3.156	-1.850	5.800	14.000	8.20	115.0	-25.90
22	.586	-3.125	-1.830	5.700	7.625	4.47	34.0	-13.94
23	.490	-2.953	-1.445	4.260	.562	.27	.1	- .81
24	.178	-2.953	- .525	1.550	2.500	.44	1.1	- 1.31
25	.148	-2.844	- .420	1.190	1.687	.25	.4	- .71
26	.292	-2.828	- .826	2.340	.625	.18	.1	- .51
27	.146	-2.625	- .384	1.010	.625	.09	.0	- .24
28	.132	-2.000	- .264	.528	.094	.01	.0	- .02
29	.116	-1.937	- .225	.436	-	-	-	-
30	.165	-2.297	- .379	.870	- 6.281	-1.03	6.5	+ 2.38
31	.165	-1.719	- .284	.487	-11.250	-1.86	20.8	+ 3.20
32	.203	2.10	.426	.894	34.810	7.06	246.0	+14.80
33	.041	2.03	.083	.168	34.820	1.43	49.6	2.90
34	.037	1.66	.061	.102	34.240	1.27	43.3	2.10
35	.041	-1.77	- .072	.128	34.830	1.43	49.6	- 2.51
36	.074	- .86	- .063	.055	34.240	2.53	86.6	- 2.16
37	.455	-2.18	- .990	2.160	31.940	14.50	464.0	-31.60
Σ	7.488		-3.210	67.830		79.61	2151.3	-63.26

T53-2510

$\bar{y} = \dfrac{-3.21}{7.488} = \underline{-.428}$ in. (Ref. I - P. A3.11) (Ref. P. 21)

$$
\begin{aligned}
I_{xx} &= \Sigma Ay'^2 - \Sigma Ax(\bar{y})^2 \\
&= 67.8 - 7.5 \times (-.428)^2 \\
&= 67.8 - 1.31 \\
&= 66.5 \text{ in.}^4
\end{aligned}
$$

(Ref. I - P. A3.11) (Ref. P. 21)

$\bar{x} = \dfrac{79.61}{7.5} = \underline{10.62}$ in.

$$
\begin{aligned}
I_{yy} &= \Sigma Ax^2 - \Sigma A \times (\bar{x})^2 \\
&= 2151.3 - 7.5 \times (10.62)^2 \\
&= 2151.3 - 847 \\
&= 1304 \text{ in.}^4
\end{aligned}
$$

(Ref. I - P. A3.11) (Ref. P. 21)

$$
\begin{aligned}
I_{xy} &= \Sigma Ax'y' - \Sigma A \times \bar{x} \times \bar{y} \\
&= -63.26 - 7.5 \times 10.62 \times -.428 \\
&= -63.26 + 34.1 \\
&= -29.16 \text{ in.}^4
\end{aligned}
$$

(Ref. I - P. A3.11) (Ref. P. 21)

$\text{Tan } 2\phi = \dfrac{2 I_{xy}}{I_y - I_x}$ (Ref. I - P. A3.11)

$\text{Tan } 2\phi = \dfrac{-58.32}{1237.5} = -.0472$

$\phi = \underline{-1^\circ 20'}$

$I_{xp} = I_x \text{ Cos}^2\phi + I_y \sin^2\phi - 2 I_{xy} \sin\phi \times \text{Cos}\,\phi$ (Ref. I - P. A3.11)

$I_{xp} = 66.5 \times (.999)^2 + 1304 \times (.0236)^2 - [2 \times -29.16 \times -.0236 \times .999]$

$I_{xp} = 66.5 + .73 - 1.37$

$I_{xp} = 66 \text{ in.}^4$

$I_{yp} = I_x \sin^2\phi + I_y \text{ Cos}^2\phi + 2 I_{xy} \sin\phi \times \text{Cos}\,\phi$ (Ref. I - P. A3.12)

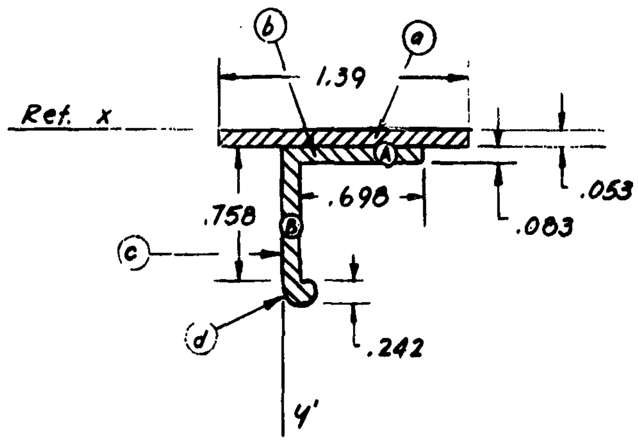
$I_{yp} = 66.5 \times (.0236)^2 + 1304 \times (.999)^2 + [2 \times -29.16 \times -.0236 \times .999]$

$= .037 + 1304 + 1.37$

$= 1305 \text{ in.}^4$

Section Properties - Wing Station 179.4

Bulb Angle Section - Items 1, 2, 3, 9, 10, 11, 12. (Ref. P. 20)



Buckling Stress

Element A

$$\frac{b_1}{t_1} = \frac{.698}{.083} = 8.4$$

$F_{cr_1} =$ 38,000 psi (Ref. I - Fig. B5.13)

Element B

$$\frac{b_2}{t_2} = \frac{.917}{.083} = 11.0$$

$F_{cr_2} =$ 48,750 psi (Ref. I - Fig. B5.13)

$$F_{cs} = \frac{(F_1\ b_1 + F_2\ b_2)}{b_1 + b_2}$$ (Ref. I - P. B5.7(6))

$$F_{cs} = \frac{(38{,}000 \times .698) + (48{,}750 \times .917)}{.698 + .917}$$

$$F_{cs} = \frac{71{,}100}{1.615} = 44{,}000 \text{ psi}$$

T53-2510

Section Properties - Wing Station 179.4

Effective Skin (Ref. I - P. B4.2(6))

$$w = 1.70 \times .053 \sqrt{\frac{10.3 \times 10^6}{4.4 \times 10^4}}$$ (Ref. P. 23)

$$w = .09 \times 15.3$$

$$w = 1.39 \text{ in.}$$

Section Properties (Ref. P. 23)

Item	Area	y'	$A_{y'}$	$A_{y'^2}$	x'	$A_{x'}$
a	.074	.026	.002	.0	.432	.032
b	.058	.094	.005	.0	.432	.025
c	.063	.432	.027	.013	.041	.003
d	.046	.932	.043	.040	.121	.005
Σ	.241	$\bar{y}$ = .321	.077	.053	$\bar{x}$ = .270	.065

$$\bar{y} = \frac{\Sigma A_{y'}}{\Sigma A} = \frac{.077}{.241} = .321 \text{ in.}$$ (Ref. I - P. A3.11)

$$\bar{x} = \frac{\Sigma A_{x'}}{\Sigma A} = \frac{.065}{.241} = .270 \text{ in.}$$

$$I_{xx} = \Sigma A_{y'^2} - \Sigma A_{\bar{y}}^2$$ (Ref. I - P. A3.11)

$$I_{xx} = .053 - .241 \times (.321)^2$$

$$I_{xx} = .053 - .025$$

$$I_{xx} = .0283 \text{ in.}^4$$

$$\rho = \sqrt{\frac{I_x}{A}}$$ (Ref. I - P. A3.5)

$$\rho = \frac{.0283}{.2406} = .344 \text{ in.}$$

Johnson's Parobolic Equation

$$F_c = F_{cs} - \frac{F_{cs}^2}{4\, c\, \pi} \times \frac{\left(\frac{L}{\rho}\right)^2}{2E}$$ (Ref. I - P. B6.4(3))

$$F_c = 44{,}000 - \frac{(44{,}000)^2 \times \left(\frac{11.75}{.344}\right)^2}{4 \times 2 \times (3.14)^2 \times 10.3 \times 10^6}$$ (Ref. P. 23)

$$F_c = 44{,}000 - 2800$$

$$F_c = 41{,}200 \text{ psi}$$

Section Properties - Wing Station 179.4

Revised Effective Skin

$w = 1.7\ t \sqrt{\frac{E}{F_c}}$ (Ref. I - P. B6.4)

$w = 1.7 \times .053 \sqrt{\frac{10.3 \times 10^6}{4.12 \times 10^4}} = 1.43$ in. (Ref. P. 24)

$A = 1.43 \times .053$

$A = .076$ in.^{2}

$A = .167$ in.^{2} (Ref. P. 24 b, c, d)

$A = .243$ in.^{2} Total Area

Buckling Stress of Skin Between Rivets

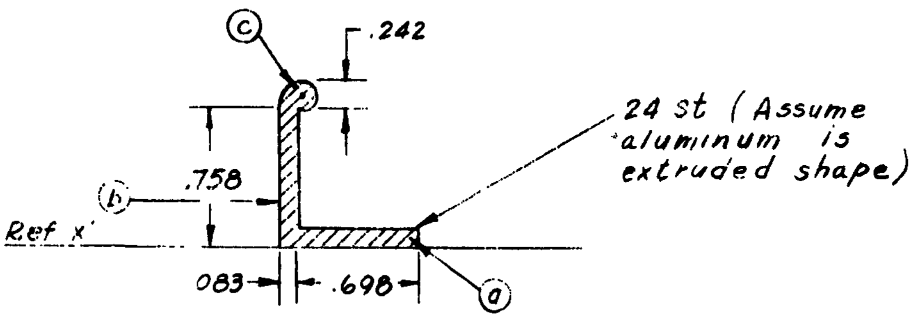
Rivet Spacing = 1.00 in.

F_c = Inter-rivet Buckling Stress of Skin

F_c = 43,000 psi (Ref. I - Fig. B4.4)

Typical Bulb Angle

Column Allowable Buckling Stress



T53-2510

Section Properties - Wing Station 179.4

Section Properties (Ref. P. 25)

Item		A	y'	Ay'	Ay'^{2}
a	.698 x .083	.058	.041	.0024	.0001
b	.758 x .083	.063	.378	.0238	.009
c	π x $(.121)^2$	.046	.879	.0404	.0354
	Σ	.167	y=.398	.0666	.0445

$$\bar{y} = \frac{\Sigma Ay'}{\Sigma A}$$ (Ref. I - P. A3.11)

$$\bar{y} = \frac{.0666}{.167} = .398 \text{ in.}$$

$$I_{xx} = \Sigma Ay'^2 - \Sigma Ay^2$$ (Ref. I - P. A3.11)

$$I_{xx} = .0445 - .167 \times (.398)^2$$

$$I_{xx} = .0445 - .0264$$

$$I_{xx} = .0181 \text{ in.}^4$$

$$\rho = \sqrt{\frac{I_{xx}}{A}}$$ (Ref. I - P. A3.5)

$$= \frac{.018}{.167}$$

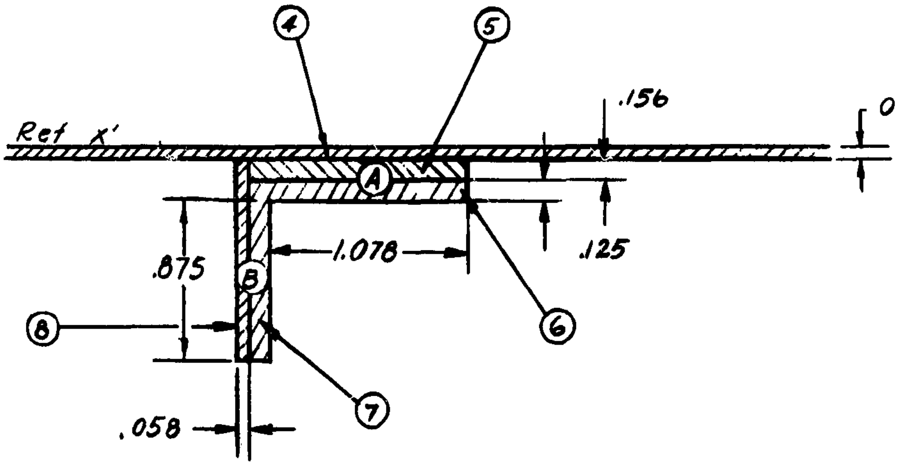
$$= .328"$$

$$\frac{L}{\rho} = \frac{11.75}{.328} = 35.8$$

$$F_c = 37{,}500 \text{ psi}$$ (Ref. I - Fig. B1.10)

Section Properties - Wing Station 179.4

Front Spar Section - Items 4, 5, 6, 7, 8. (Ref. P. 20)



Buckling Stress

Element A

$$\frac{b_1}{t_1} = \frac{1.078}{.125 + \frac{.156}{2}} = 5.3$$

F_{cr_1} = 44,500 psi (Ref. I - Fig. B5.13)

Element B

$$\frac{b_2}{t_2} = \frac{.875}{.125 + \frac{.058}{2}} = 5.7$$

F_{cr_2} = 44,000 psi (Ref. I - Fig. B5.13)

$$F_{cs} = \frac{(44,500 \times 1.078 \times .203) + (44,000 \times .875 \times .154)}{(1.078 \times .203) + (.875 \times .154)}$$ (Ref. I - P. B5.7 (5))

$$F_{cs} = \frac{9750 + 5940}{.354} = \frac{15690}{.354} = 44,300 \text{ psi}$$

T53-2510

Section Properties - Wing Station 179.4

Effective Skin - Item #4

$$w = 1.7\ t \sqrt{\frac{E}{F_{cs}}}$$ (Ref. I - P. B4.2(6))

$$w = 1.7 \times .053 \sqrt{\frac{10.3 \times 10^6}{4.43 \times 10^4}}$$ (Ref. P. 27)

$$w = .09 \times 15.3$$

$$w = 1.37 \text{ in.}$$

Section Properties (Ref. P. 27)

Item	A	y'	Ay'	Ay²
4 1.37 x .053	.073	.026	.0019	0
5 1.203 x .156	.187	.131	.0245	.0032
6 1.078 x .125	.135	.271	.0366	.0099
7 1.00 x .125	.125	.709	.0886	.0628
8 1.156 x .058	.067	.631	.0423	.0268
Σ	.587	ȳ=.326	.1939	.1027

$$\bar{y} = \frac{\Sigma A_{y'}}{\Sigma A} = \frac{.194}{.595} = .326 \text{ in.}$$ (Ref. I - P. A3.11)

$$I_{xx} = \Sigma A_{y'}{}^2 - \Sigma A_{\bar{y}}{}^2$$ (Ref. I - P. A3.11)

$$I_{xx} = .1027 - .595 \times (.326)^2$$

$$I_{xx} = .040 \text{ in.}^4$$

$$\rho = \sqrt{\frac{I_{xx}}{A}} = \sqrt{\frac{.040}{.595}} = .26 \text{ in.}$$ (Ref. I - P. A3.5)

Johnson's Parabolic Column Equation

$$F_c = F_{cs} - \frac{F_{cs}{}^2 \times \left(\frac{L}{\rho}\right)^2}{4\ C\pi^2\ E}$$ (Ref. I - P. B6.4(3))

$$F_c = 44{,}300 - \frac{(44{,}300)^2 \times \left(\frac{11.75}{.26}\right)^2}{8.12 \times 10^8}$$

$$F_c = 44{,}300 - 4950 = 39{,}350 \text{ psi}$$

Section Properties - Wing Station 179.4

Revised Effective Skin (Ref. I - P. B6.4)

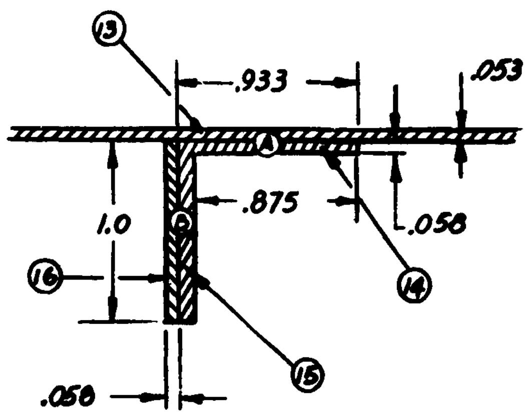
$$w = 1.70 \times .053 \sqrt{\frac{10.3 \times 10^6}{3.935 \times 10^4}}$$ (Ref. P. 28)

$$w = 1.46 \text{ in.}$$

$$A = 1.46 \times .053$$

$$= .077 \text{ in.}^2$$

Rear Spar Section - Items 13, 14, 15, 16. (Ref. P. 20)



Buckling Stress

Element A

$$\frac{b_1}{t_1} = \frac{.875}{.058} = 15.05$$

$$F_{cr_1} = 19{,}500 \text{ psi}$$ (Ref. I - Fig. B5.12)

T53-2510

Section Properties - Wing Station 179.4

Element B

$\frac{b_2}{t_2} = \frac{.942}{.087} = 10.8$ (Ref. P. 29)

$F_{cr_2} = 31,500$ (Ref. I - Fig. B5.12)

$F_{cs} = \frac{(19,500 \times .875 \times .058) + (31,500 \times .942 \times .087)}{(.875 \times .058) + (.942 \times .087)}$ (Ref. I - P. B5.7 (5))
(Ref. P. 29)

$F_{cs} = \frac{990 + 2580}{.0507 + .0819} = \frac{3570}{.1326}$

$F_{cs} = 26,900$ psi

Effective Skin Width

$w = 1.7 \times .053 \sqrt{\frac{10.3 \times 10^6}{2.69 \times 10^4}}$ (Ref. I - P. B4.2(6))

$w = 1.77$ in.

Section Properties (Ref. P. 29)

Item		A	y'	Ay'	Ay'²
13	1.77 x .053	.094	.026	.0024	.0001
14	.875 x .058	.051	.082	.0042	.0003
15	1.00 x .058	.058	.553	.0321	.0177
16	1.00 x .058	.058	.553	.0321	.0177
	Σ	.261	ȳ = .272	.0708	.0358

$\bar{y} = \frac{\Sigma Ay'}{\Sigma A}$ (Ref. I - P. A3.11)

$\bar{y} = \frac{.071}{.261} = .272$ in.

$I_{xx} = \Sigma Ay'^2 - \Sigma A\bar{y}^2$ (Ref. I - P. A3.11)

$I_{xx} = .036 - (.261 \times (.272)^2$

$I_{xx} = .036 - .0193 = .0167$ in.^{4}

Section Properties - Wing Station 179.4

$$\rho = \sqrt{\frac{I_{xx}}{A}}$$ (Ref. I - P. A3.5)

$$= \sqrt{\frac{.0167}{.261}}$$ (Ref. P. 30)

$$= .253 \text{ in.}$$

Column Allowable Buckling Stress

$$F_c = F_{cs} - \frac{F_{cs}^2 \times \left(\frac{L}{\rho}\right)^2}{4\, c\, \pi^2\, E}$$ (Ref. I - P. B6.4(3))

$$F_c = 26{,}900 - \frac{(26{,}900^2) \times \left(\frac{11.75}{.253}\right)^2}{8.12 \times 10^8}$$ (Ref. P. 30)

$$F_c = 26{,}900 - 1920 = 24{,}980$$

$$F_c = 24{,}980 \text{ psi}$$

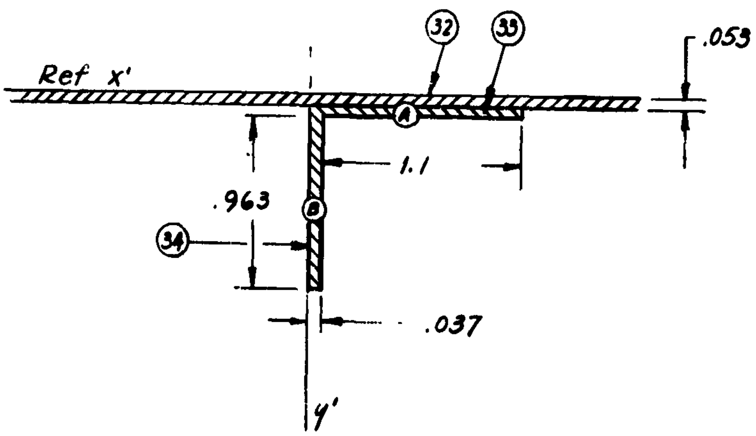
Revised Effective Skin (Ref. I - P. B6.4)

$$w = 1.7 \times .053 \sqrt{\frac{10.3 \times 10^6}{2.498 \times 10^4}}$$

$$w = 1.835 \text{ in.}$$

$$A = 1.835 \times .053 = .097 \text{ in.}^2$$

Aileron Closure Spar - Items 32, 33, 34. (Ref. P. 20)



T53-2510

Section Properties - Wing Station 179.4

Buckling Stress

Element A (Ref. P. 31)

$$\frac{b_1}{t_1} = \frac{1.1}{.037} = 29.8$$

F_{cr_1} = 5,000 psi (Ref. I - Fig. B5.12)

Element B

$$\frac{b_2}{t_2} = \frac{.963}{.037} = 26$$

F_{cr_2} = 7,000

$$F_{cs} = \frac{(5{,}000 \times 1.1) + (7{,}000 \times .963)}{1.1 + .963}$$ (Ref. I - P. B5.7(6))

$$F_{cs} = \frac{5{,}500 + 6{,}740}{2.063}$$

$$F_{cs} = \frac{12{,}240}{2.063} = 5940$$

Effective Skin

$$w = 1.7 \times .053 \sqrt{\frac{10.3 \times 10^6}{5.94 \times 10^3}}$$ (Ref. I - P. B4.2(6))

w = 3.74 in.

Section Properties

(Ref. P. 31)

Item		A	y'	Ay'	Ay'^2	x'	Ax'
32	3.74 x .053	.198	.0265	.0052	.00014	.5685	.1125
33	1.10 x .037	.0407	.0715	.0029	.00021	.5685	.0231
34	1.0 x .037	.037	.5053	.0187	.00945	.0185	.0007
	Σ	.2757	y = .103	.0268	.00980	x = .485	.1363

Section Properties - Wing Station 179.4 (Ref. I - P. A3.11)

$\bar{y} = \frac{.0268}{.2757} = .103$ in. (Ref. P. 32)

$\bar{x} = \frac{\Sigma A_{x'}}{\Sigma A} = \frac{.1363}{.2757} = .485$ in.

(Ref. I - P. A3.11)

$I_{xx} = .0098 - (.2757 \times (.103)^2$ (Ref. P. 32)

$I_{xx} = .0098 - .0029$

$I_{xx} = .0069$ in.^{4}

$\rho = \sqrt{\frac{.0069}{.2757}} = .158$ in. (Ref. I - P. A3.5)

Buckling Stress of Column (Ref. I - P. B6.4(3))

$F_c = 5{,}940 - \frac{(5{,}940)^2 \times \left(\frac{11.75}{.158}\right)^2}{8.12 \times 10^8}$ (Ref. P. 32)

$F_c = 5{,}940 - \frac{35.6 \times 10^6 \times (74.4)^2}{8.12 \times 10^8}$

$F_c = 5940 - \frac{1940}{8.12}$

$F_c = 5940 - 239 = 5{,}701$ psi

Revised Effective Skin (Ref. I - P. B6.4)

$w = 1.7 \times .053 \sqrt{\frac{10.3 \times 10^6}{5.701 \times 10^3}}$

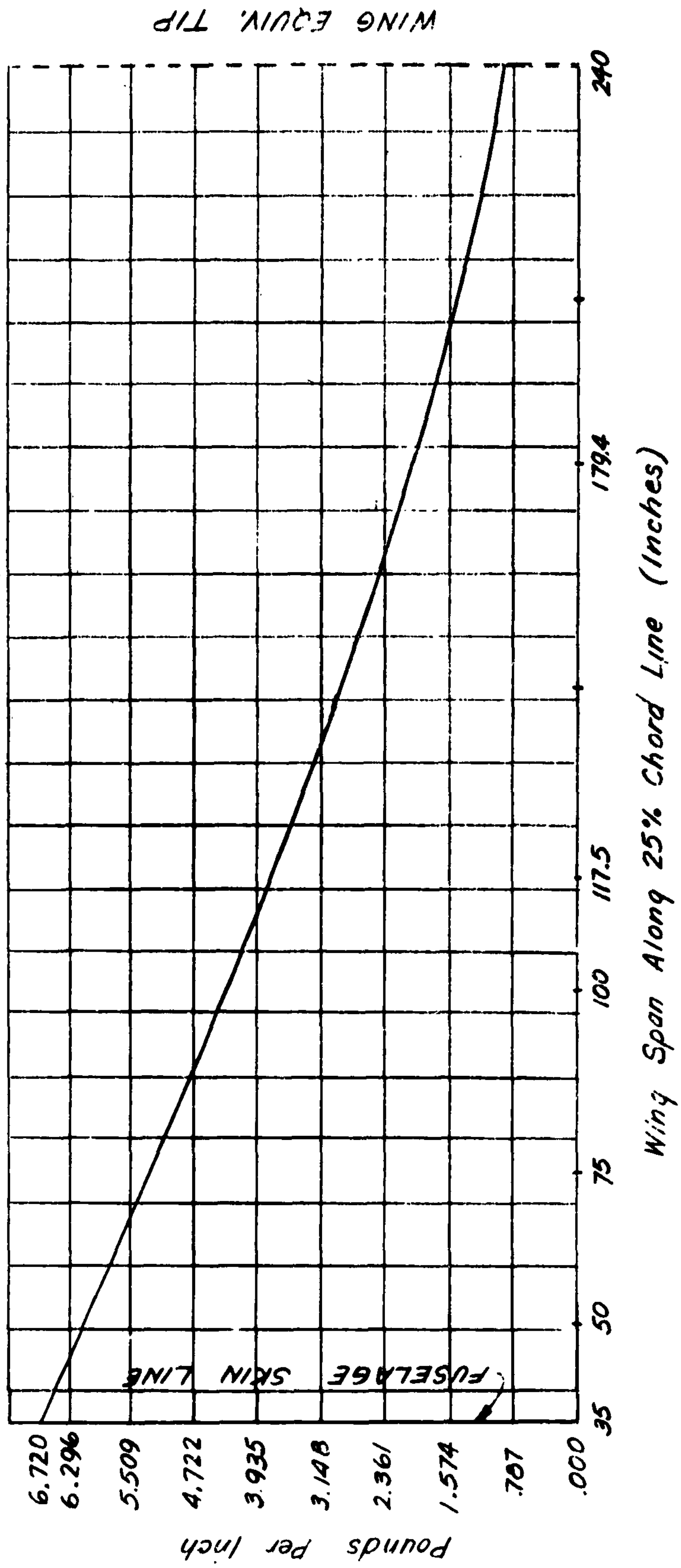
$w = 3.82$ in.

Area of Skin

$A = 3.82 \times .053 = .203$ in.^{2}

T53-2510

MIG-15 SPAN-WISE DEAD WEIGHT DISTRIBUTION
TOTAL DISTRIBUTED WEIGHT L & R 1383 LBS.
SEMI-SPAN WEIGHT - 692 LBS



SECTION II

UNIT BENDING MOMENTS

UNIT DEAD WEIGHT BENDING MOMENTS

(Ref. P. 34)

(1) Station	(2) Shear (Lbs.)	* (3) Arm (In.) C.G. to Sta.	(4) Moment (in.lbs.) (2) x (3)
179.4	91.5	26.2	2,400
117.5	-	-	2,400
	91.5	61.9	5,650
	179.5	27.2	4,880
Σ	271.0	-	12,930
35.0	-	-	12,930
	271.0	82.5	22,300
	421.0	37.2	15,600
Σ	692.0	-	50,830 +

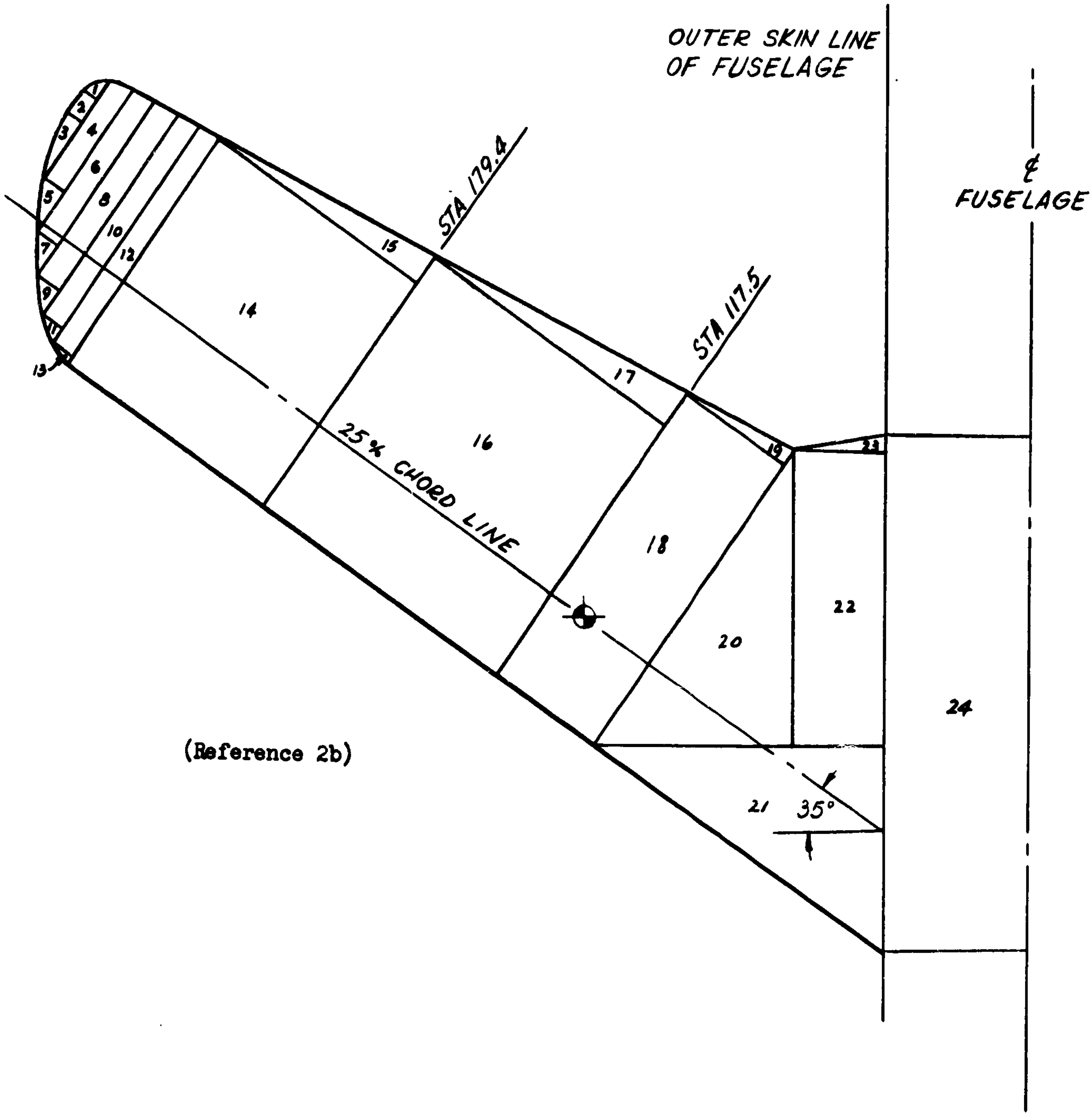
*NOTE - The moment arms for above items were measured along 25% chord line.

\+ To account for Wing sweepback of 35° at 25% Chordline.

$$M_w = 50{,}830 \times \cos 35^\circ = 41{,}600 \text{ in.lb.}$$

T53-2510

WING PLANFORM



(Reference 2b)

Fig. 4

UNIT BENDING MOMENTS FOR 1000 LB. AIRLOAD

Wing Tip (Sta. 266.5) to Wing Station 179.4

(1) Item	(2) Area	(3) Load (Lbs.)	(4) *Arm (Inches)	(5) Moment (in.lbs.)
(Ref. P. 36)	in.^{2}	.0625 x (2)	CG to Sta. 179.4	(3) x (4)
1	5.4	.34	74.5	25.2
2	17.4	1.08	75.0	81.0
3	18.7	1.17	74.5	87.0
4	107.0	6.7	71.5	478.0
5	26.5	1.66	70.5	117.0
6	163.5	10.25	66.3	680.0
7	19.5	1.22	65.3	79.6
8	206.0	12.9	61.3	790.0
9	16.3	1.02	60.5	62.7
10	242.5	15.2	56.3	855.0
11	10.5	.66	55.3	36.5
12	267.5	16.7	51	852.0
13	5.5	.34	50.5	17.4
14	2780.0	174.0	24.5	4260.0
15	179.0	11.2	16.3	182.5
Σ	4065.0	254.4		8605.0

Wing Sta. 179.4 to Wing Sta. 117.5

(1) Item	(2) Area	(3) Load (Lbs.)	(4) *Arm (Inches)	(5) Moment (in.lbs.)
(Ref. P. 36)	in.	.0625 x (2)	CG to Sta. 117.5	(3) x (2)
1-15	4065.0	-	-	8605.0
		254.4	59.0	15000.0
16	3730.0	234.0	29.5	6900.0
17	186.6	11.7	19.6	230.0
Σ	7982.0	500.0		30,735.0

*NOTE - The moment arms for the above items were measured along the 25% chord line.

T53-2510

UNIT BENDING MOMENTS FOR 1000 LB. AIRLOAD

Wing Station 117.5 to Fuselage Skin Line (Wing Sta. 35)

(1) Item	(2) Area	(3) Load (Lbs.)	(4) *Arm (Inches)	(5) Moment (in.lbs.)
(Ref. P. 36)	in.^{2}	q x (2)	CG to Sta. 35	(3) x (4)
1-17	7982.0	-	-	24,800 †
	-	500.1	58.5	29,200
18	1690.0	106.0	48.5	5,140
19	34.2	2.1	25.0	54
20	1220.0	76.5	31.0	2,370
21	1170.0	73.6	19.5	1,440
22	1040.0	65.2	9.0	586
23	15.8	1.0	6.0	6
Σ	13,152.0	824.4	-	63,596
24	2,910.0			
Σ	16,062.0 ǂ			

*NOTE - The moment arms were measured as perpendicular distances from the fuselage skin line to the centroids of the above items.

† To account for the wing sweepback of 35° at 25% chordline.

$$\therefore \Sigma M_a = 30,735 \times \cos 35^\circ = 24,800 \text{ in.lb.}$$ (Ref. P. 37)

ǂ Area of section from Sta. 35 to fuselage centerline.

$$\therefore q = \frac{1000}{16062} = .0625 \text{ psi}$$

T53-2510

SECTION III

DETERMINATION OF LOAD FACTORS

For any point on a section, the load factor

$$N = \frac{IF_c}{y\,(M_a - M_w)}$$

Where:

I	=	Moment of inertia of section	
M_a	=	Airload moment, in.-lbs. for 1 g	
M_w	=	Dead weight moment, in.-lbs. for 1 g	
y	=	Distance from principal axis from drawing	(Ref. 2a)
F_c	=	Allowable stress	

At Sta. 117.5

M_a	=	30735 x 5.1 = 156,900	(Ref. P. 37)
M_w	=	12930	(Ref. P. 35)
I	=	192.4	(Ref. P. 9)

$$N = \frac{192.4\ F_c}{143800\ y} = .001338\ \frac{F_c}{y}$$

At Sta. 179.4

M_a	=	8605 x 5.1 = 43,900	(Ref. P. 37)
M_w	=	2400	(Ref. P. 35)
I	=	66	(Ref. P. 22)

$$N = \frac{66\ F_c}{41500\ y} = .001592\ \frac{F_c}{y}$$

The calculations are included in a table on page

At Sta. 0

M_a	=	63,596 x 5.1 = 324,000	(Ref. P. 38)
M_w	=	41,600	(Ref. P. 35)

Determination of Load Factors

Sta. 117.5

Item	(1)		(2)	(3)	(4)
Ref. p - (7)	F_c		y*	F_c /y	N
		Ref.		(1)/(2)	.001338x(3)
2	41380	P. 11	4.3	9630	12.9
3	41380	P. 11	4.4	9420	12.6
4-10	42830	P. 15	4.42	9700	13.0
20-27	37260	P. 18	2.03	18400	24.6
15	43040	P. 13	4.1	10750	14.4

Sta. 179.4

Item	(1)		(2)	(3)	(4)
Ref. p - (20)	F_c		y*	F_c /y	N
		Ref.		(1)/(2)	.001592x(3)
3	41200	P. 24	3.8	10830	17.3
4-8	39350	P. 28	4.12	9570	15.2
9	41200	P. 24	4.5	9150	14.6
11	41200	P. 24	4.80	8580	13.7
13-16	24980	P. 31	4.35	5850	9.15

*NOTE - These values are scaled from drawing. (Ref. 2a)

At Sta. 0

(Ref. P. 6)

$$I_{xx} = 74.7 \text{ in.}^4$$
$$y = 4.29$$

$$N = \frac{IF_c}{y\,(M_a - M_w)}$$

$$= \frac{74.7\ (174000)}{4.29\ (324000 - 41600)} = 10.75$$ (Ref. P. 39)

T53-2510

BIBLIOGRAPHY

1. E. F. Bruhn - "Analysis and Design of Airplane Structures" - Tri-State Offset Company - 1949 Rev. Ed.

2. C.A.L. Drawings
   (a) No. 391-5-1013
   (b) No. 391-5-1002

3. Work Statement Exhibit "A"
   Enclosure (A) to C.A.L. letter RFF:emc-446 - 10/31/52

4. TR-AC-6 - C.A.L. Bill of Material Study

APR 9 1953

[redacted]

SECRET

Technical Report No. TR-AC-17

DISTRIBUTION LIST

Organization	No. Copies	Organization	No. Copies
AFODC	1	AU-ACSS	1
AFMAI	1	D/S	1
AFOAC	1	J.I.C.	2
AFOIN	22	ONI	75
AFOPL	1	RDB	2
AFDRQ	1	RDB-FIB	1
AFDRD	2	AFOAC-E/T	2
ADC	3	WSEG	2
AMC-MCP, MCPB, MCPP	3	AFSA	1
APG	4	MATS	1
ARDC	4	Natl War College	1
ATRC	15	7th Air Div	1
ALAC	12	USAFSS	5
ALC	1	NACA, Washington	1
CAirC	1	NACA, Langley	1
ConAC	1	NACA, Lewis	1
NEAC	1	NACA, Ames	1
AFSWC	1	CIA	8
SAC	12	RAND	4
TAC	2	DA G-4	1
CADF	1	USAFE, A-2	3
FEAF	1	12th AF, A-2	8
USAFE	4	FEAMC	1
EADF	1	ATIA	1
FEAF Intell Div	5	ATIX	1
3rd AF	3	ATISD-3	1
USFA	2	ATISE-1	1
WADF	1	ATIAA	4
4 AF	1	Aberdeen Pvg Grd	1
Av Eng Force	1	Air Weapons Rsch Cen.	1
1142nd USAF Sp. Act. Sqd.	1	WCOSI	1
AA Ankara, Turkey	1	WCOE	1
AA London, England	1	WCOW	1
AA Paris, France	1	WCOWP	1
AA Rome, Italy	1	WCLO	1
AA Stockholm, Sweden	1	WCLBE	1
AA Bern, Switzerland	1	WCLPP	1
RADC	1	WCLSO	2
Edwards AFB	4	WCRO	1
Arnold Eng. Dev Cen	1	WCTE	1
Patrick AFB	1	USAF AGOS-Librarian	1
6540th AFMTW Holloman AFB	1	ASTIA	1
AU	3	Hq USAFSS-Arlington	1
Asst C/S, G-2	16	ATIRC-1	1
9th AF	1	NSA-252	1
18th AF	1	BAGR-CD	1
AU Library	2	JMIA	1

T52-2510

[redacted]

DEPARTMENT OF THE AIR FORCE
WASHINGTON, DC

23 June 2010

HAF/IMIO (MDR)
1000 Air Force Pentagon
Washington, DC 20330-1000

Bobby Sammons.
P.O. Box 1680
Cloudcroft, NM 88317-1680

Dear Mr. Sammons

Reference to your letter, undated (attachment 1) requesting a Mandatory Declassification Review (MDR) for Defense Technical Information Center (DTIC) documents:

AD004521	AD005224
AD005736	AD005735
AD006796	AD004876
AD005809	AD003234
AD005808	AD004232

The review for the documents have been completed and the declassification has been downgraded to UNCLASSIFIED and copies are attached for your information.

Address any questions concerning this review to the undersigned at (703) 692-9979 and refer to our case number 07-MDR-076.

Sincerely

JOANNE MCLEAN
Mandatory Declassification Review Specialist

2 Attachments
1. Letter, Request for Documents
2. 10 DTIC Documents

cc: DTIC w/o documents